Technique for Efficient Information Retrieval in Outpatient Systems

James Marshall, PhD, E. Andrew Balas, MD, PhD, and John C. Reid, PhD

Medical Informatics Research Group, School of Medicine
University of Missouri, Columbia, Missouri

In the era of managed care, quality of medical care standards continue to materialize. Most of these standards have long, cumbersome, and complex rules. In light of such problematic rules, efficient ways of retrieving information for a computerized score card are needed. A technique for making such rules less difficult to use is to create Boolean expressions for each quality of care indicator. These Boolean expressions partition the indicators into key words and phrases so that information can be retrieved readily from a system. This study incorporates an outpatient clinical information system of a major university hospital. The technique used to retrieve information and related issues are discussed in the following text.

INTRODUCTION

Current advances in the evaluation of quality or effectiveness of medical care have enabled providers and other interested persons to identify standards for quality medical care[1-4]. These standards tend to be lengthy, awkward, and complicated to use. Consequently, there is a need for ways to translate or to modify these standards into concise query language for multiple databases. The lengthy form of the standards may be more suitable when information is needed from paper medical records but less suitable when information is needed from a computerized system, particularly an outpatient system. Even though many quality of care standards have been developed recently, few standards address how one should get the information from an outpatient system. A set of widely used standards known as the Health plan Employer Data and Information Set (HEDIS) provides measurement specifications for computerized systems but even they do not provide sufficiently detailed guidance on retrieving quality of care information[5-6]. Modification of current lengthy standards may enable more efficient retrieval of quality of care information.

A technique for modifying lengthy standards involves creating a Boolean expression for each standard. A Boolean expression is a group of keywords joined by Boolean AND and OR operations[7]. Even though Boolean expressions were used previously in several other information retrieval contexts, including decision analysis and interfaces[8-10], the use of such expressions remains unreported in quality of care contexts.

For this study, the domain of analysis was the outpatient system of a university hospital known as the IDX Database. The IDX Database comprises information about patient demographics, billing, clinical data, and procedural and disease coding. In order to query the database, information must be expressed clearly and succinctly so that the correct information is obtained. Outpatient systems, like the IDX Database, were designed to meet the information needs of ambulatory care providers and to improve the delivery of quality medical care[11].

The first objective of this study was to determine an appropriate set of standards for quality of care in an outpatient setting. The second objective was to develop a technique for retrieving quality of care information from an outpatient database. Moreover, the last objective was to suggest that the technique could improve the efficiency of information retrieval involving lengthy and complex quality of care standards.

Table 1. Quality of Care Indicators

Childhood immunization status
Adolescent immunization status
Flu shots for high risk adults
Flu shots for older adults
Breast cancer screening
Cervical cancer screening
Low birth weight babies
Treating children's ear infections
Eye exams for people with diabetes

METHODS

The Site and The Team

The site of the study was the University of Missouri's Health Sciences Center in central Missouri. The team, which was assigned to projects involving quality of managed care, comprised the following members from

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the School of Medicine, University of Missouri-Columbia: Graduate students enrolled in the Health Services Management Program, a representative from the Missouri Integrated Advanced Information Management Systems project, medical informatics fellows, and informatics faculty.

Quality of Care Indicators

The quality of care indicators used in this study are listed in Table 1. These indicators were adapted from a set of effectiveness of care indicators in HEDIS version 3.0[12]. For purposes of demonstrating the technique for information retrieval, only the childhood immunization status and breast cancer screening indicators were used as samples (Tables 2 and 3). These particular indicators were used because they demonstrate the long length and complexity characteristic of most quality of care indicators. Tables 2 and 3 include descriptions of a numerator and a denominator that are used to calculate a rate of quality compliance for each indicator. Quality of care rates can offer providers of care, purchasers, and consumers important information about the quality of medical care for a given population. Eventually, these types of rates may serve as the basis of comparison and information sharing across health care settings.

Table 2. Sample Quality of Care Indicator

Childhood Immunization Status

Denominator
All members whose second birthday occurred during the reporting year, who were members of the plan as of their second birthday, and who were continuously enrolled for the 12 months immediately preceding their second birthday.

Numerator
The number of members in the denominator who received the following number of immunizations:
(4) diphtheria-pertussis-tetanus (DPT),
(3) polio (IPV or OPV),
(1) measles-mumps-rubella (MMR),
(1) H influenza type b vaccination (HIB), and
(2) hepatitis B vaccinations (HB).

Table 3. Sample Quality of Care Indicator

Breast Cancer Screening

Denominator
All enrolled women aged 52-69 years old as of December 31 of the reporting year, who were members of the plan as of December 31 of the reporting year, and who were continuously enrolled during the reporting year and the preceding year.

Numerator
The number of members in the denominator who have had one (or more) mammograms during the prior two years.

Indicator Measurement Methods

The first step towards measuring the quality of care indicator was to identify the appropriate database. For outpatient information the suitable database was the IDX Database. This database comprises key clinical and financial data, and it consolidates information on medical records data as well as patient demographic data. Also, the database provides information and reports to support operations and decision making from an institutional-wide perspective. Furthermore, the financial data information in the database enables one to identify procedural and disease codes that can be used to capture information about a specific population.

The next step towards measuring the indicators was to modify them into Boolean expressions. A Boolean expression is a type of database query language that allows one to frame a query as a logical combination of keywords. The keywords are joined by Boolean AND and OR operations. For this study, Boolean expressions were needed for two reasons. First, Booleans were needed to partition the enormous amount of measurement information on each indicator. Second, Booleans were needed to facilitate the identification of the appropriate reimbursement codes for each indicator.

In order to set up the indicators for the Boolean expressions, they were partitioned into keywords of applicable procedures, medical tests, diagnoses, age ranges, and dates of service. Then, these phrases were joined by the appropriate operators (AND and OR). Table 4 identifies the Boolean expression for childhood immunization status incorporating keywords and Boolean operators.

Table 4. Boolean Expression of Sample Quality of Care Indicator

Childhood Immunization Status
IF (age=2yrs AND 4 DPT, AND 3 IPV OR OPV, AND 1 MMR, AND 1 HIB AND 1 HB) THEN Eligible for quality report

Table 5. Coded Boolean Expression of Sample Quality of Care Indicator

Childhood Immunization Status	
IF (age=2yrs	
AND 4	CPT90701 AND/OR CPT90711 AND/OR CPT90720,
AND 3	CPT90711 AND/OR CPT90712 AND/OR CPT90713,
AND 1	CPT90704 AND/OR CPT90705 AND/OR CPT90707 AND/OR CPT90709 AND/OR CPT90710,
AND 1	CPT90706 AND/OR CPT90707 AND/OR CPT90708 AND/OR CPT90709 AND/OR CPT90710,
AND 1	CPT90720 AND/OR CPT90737)
THEN Eligible for quality report	

RESULTS

Using the Boolean expression technique (Table 4), all nine of the quality of care indicators (Table 1) were modified easily. In order to show how this technique can enable the retrieval of quality of care information from an outpatient database, the results of the technique are demonstrated by using codes that are assigned to each phrase where applicable. The codes assigned are diagnosis and procedural codes which provide a link from the standard, represented by an indicator, to clinical fields in the database that are represented by a billable code. For the purpose of keeping this section to a reasonable length, we report the resulting coded Boolean expressions for two indicators, childhood immunization status and breast cancer screening.

Table 5 reports the coded Boolean expression for the childhood immunization status indicator. The expression incorporates phrases, Boolean operators, and clinical procedural (CPT) codes. Basically, for the immunization indicator, CPT codes were assigned to each previously partitioned phrase (Table 4) resulting in a coded Boolean expression.

Table 6 reports the uncoded and coded Boolean expressions for the breast cancer screening indicator. The uncoded expression represents keywords partitioned into three phrases expressing gender, age range, and mammogram status. The uncoded expression was very useful in developing the coded Boolean expression that assigns CPT, disease (ICD), and revenue (REV) codes to the mammogram status phrase of the expression.

Table 6. Uncoded and Coded Boolean Expressions of Sample Quality of Care Indicator

Breast Cancer Screening

Uncoded Boolean expression
IF (female
AND btwn ages 52-64,
AND 1 mammogram in last 2 yrs)
THEN
Eligible for quality report

Coded Boolean expression
IF (female
AND btwn ages 52-64,
AND 1 CPT76090 OR
CPT76091 OR
CPT76092 OR
ICD87.36 OR
ICD87.37 OR
REV401 OR
REV403 in last 2yrs)
THEN
Eligible for quality report

DISCUSSION

In this study, the overall finding was that Boolean expressions represent a practical and an efficient way to develop a technique for modifying lengthy quality of care standards into expressions that are concise and succinct. These concise expressions, which are lacking in most sets of quality standards, provide sufficiently detailed guidance on retrieving quality of care information from an outpatient system.

The impetus for this work was to develop a computerized quality of medical care score card that provides ratings, based on a numerator and denominator, for each quality indicator available in a hospital outpatient system. This computerized score card would be used for administrative purposes. Competition from many independent health plans, which already have computerized score cards, will force most hospitals to measure and to report quality of care efforts if they plan to succeed in an outpatient care market[13]. Table 7 shows an example of the attributes of a score card. The major implication of the work in this study leading to a computerized score card is that only clarity and conciseness of information retrieved make it possible to report such specific quality of care rates.

Table 7. Example of Quality of Care Score Card

Indicator	Rate
Childhood immunization status	.76
Adolescent immunization status	.75
Flu shots for high risk adults	.88
Flu shots for older adults	.80
Breast cancer screening	.88
Cervical cancer screening	.82
Low birth weight babies	.29
Treating children's ear infections	.63
Eye exams for people with diabetes	.77

Besides administrative purposes, another impetus for this work was to develop a provider reminder or decision-supported system for physicians and other providers who may be interested in quality measurement.

Even though the information for this study was housed in an outpatient system, there is no reason to suggest that the Boolean expression technique should be limited to outpatient data only. The technique can be applied to retrieve inpatient data as well. Ideally, both outpatient and inpatient data would be housed in the same system and the Boolean expression technique could be used for all data in the one system.

CONCLUSION

The conciseness and clarity of the Boolean expressions make it possible to suggest that the technique could improve the efficiency of information retrieval involving lengthy and complex quality of care standards. Indeed, efficiency of processes represents a significant characteristic of quality medical care. The technique described in this study can be extended to other work involving standards and policies of any type.

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References

1. Bergman R. Iowa study helps consumers, employers evaluate health plans. *Hospitals & Health Networks* 1993; 67:60.

2. Emanuel EJ, Emanuel LL. What is accountability in health care? *Annals of Internal Medicine* 1996; 124:229.

3. Kenkel PJ. *Report cards: what every health care provider needs to know about HEDIS and other performance measures.* Gaithersburg, MD: Aspen Publishers, 1995.

4. Robinson JC. The changing boundaries of the American hospital. *Milbank Quarterly* 1994;72:259.

5. Corrigan JM, Nielsen DM. Toward the development of uniform reporting standards for managed care organizations: the Health Plan Employer Data and Information Set (Version 2.0). *Joint Commission Journal on Quality Improvement* 1993;19:566.

6. Treadwell R, Treadwell J. HEDIS, what is it? What does it mean to me? How does it affect my practice? *Missouri Medicine* 1995;92:330.

7. Friedman CP, Wildemuth, BM, Muriuki, MS, et al. A comparison of hypertext and Boolean access to biomedical information. In: *Proceedings of the 20th AMIA Annual Fall Symposium.* Washington, DC: Hanley & Belfus, Inc., 1996:2-6.

8. Maguire W. Modeling boolean decision rules applied to multiple-observer decision strategies. *Medical Decision Making* 1996;16(1):51-7.

9. Frisse ME, Cousins SB, Hassan SW. Information retrieval using a "digital book shelf". *Proceedings - the Annual Symposium on Computer Applications in Medical Care* 1991:803-7.

10. Glasziou P, Hilden J. Decision tables and logic in decision analysis. *Medical Decision Making* 1986;6(3): 154-60.

11. Barnett, GO. The application of computer-based medical-record systems in ambulatory practice. *New England Journal of Medicine* 1984;310(25):1643-50.

12. National Committee for Quality Assurance. *Health Plan Employer Data & Information Set, version 3.0.* Washington, DC:1997.

13. Miller RH. Competition in the health system: good news and bad news. *Health Affairs* 1996;15:107.